Vermicast explained: what it is and how it works.

Vermicast is worm-poo produced by the earthworm Eisenia Fetida (found all over the world). There are approximately 2700 species of earthworm and this specific earthworm consumes organic material and extrudes a rich natural fertiliser called vermicast. By the process of going through the worm’s gut the nature of the material is changed in a number of ways. What these changes are and how they make vermicast beneficial for plant growth is outlined below quoting a number of scientific trials and studies that span some 50 odd years.

The trials vary in terms of what crops they were conducted with but the results keep drawing the same basic conclusion. Vermicast is highly beneficial to plant growth, health and yield. At the end of the document is a case study of an apple farmer in the Free State who is using vermiculture extensively and has had immense success. This case study was in the Farmer’s Weekly in 2010 and his contact details are included if you wish to verify his claims.

Vermicast is not a man-made or manufactured product. It is created by earthworms and at Davley Organics we are working with the worms to produce it in high volumes. Considering a worm can process its own weight in a day you can imagine how many worms we work with to produce the cubic volumes we do.

The first thing to understand is that the value of vermicast lies in the plant growth stimulants, the cationic exchange rate and the soil benevolent biota.

Definitions:
Biota – Micro-organisms beneficial to the soil.
Cationic Exchange Rate – Exchange rate at which trace elements (cationic = positive) are attracted to vegetative matter (anionic = negative).

Vermicast is produced from organic materials that have taken up minerals in exactly the ratio in which they were needed to produce and sustain growth. Therefore the minerals are contained in castings in a natural balance such as is required for vigorous, healthy growth. In ordinary soil, plants usually have to seek them out but, in vermicast, they are readily available when they are needed. Significantly in vermicast there is no excess of nitrates and phosphates, which are water soluble and which, when applied in much higher concentrations in manufactured fertilizers, dissolve in run off.
**Plant growth stimulants:**

During vermicomposting process when organic matter passes through the worm’s gut, it undergoes physico-chemical and biochemical changes by the combined effect of earthworm and microbial activities.

Vermicasts are coated with mucopolysaccharides and enriched with nutrients. The cellulolytic, nitrifying and nitrogen fixing microbes are found established in the worm cast (Kale et al., 1988).

Earthworms directly cycle the nitrogen by excretion in the casts, urine and mucoprotein and through the turnover of earthworm tissues (Lee, 1985).

Earthworms increase the amount of mineralized nitrogen from organic matter in soil. The microbial composition changes qualitatively and quantitatively during passage through the earthworm intestine (Pedersen and Hendriksen, 1993).

Joshi and Kelkar (1952) reported that earthworm casts contained greater percentage of finer fractions like silt and clay than in the surrounding soils. This change in mechanical composition of soil was probably due to the grinding action of earthworm gizzard. The chemical analysis of Vermicasts revealed that they were richer in soluble salts, neutral or alkaline in reaction and had higher percentage of exchangeable Na, K and Mg but a lower exchangeable Ca than in corresponding soil.

Earthworm casts also contained greater amounts of Nitrogen (N), Phosphorous (P) and Potassium (K). The Vermicasts contained higher amounts of nitrate nitrogen and possessed a greater nitrifying power than the corresponding soils.

Vermicompost also contained Mg, Ca, Fe, B, Mo and Zn in addition to some of the plant growth promoters and beneficial microflora.

Several valuable compounds were also produced through the earthworm – microfloral interaction, which included vitamins such as B12 and plant growth hormones such as gibberellins.

This important concept, that Vermicompost includes plant-growth regulators which increase growth and yield, has been cited and is being further investigated by several researchers (Canellas et al, 2002).

Barois et al., (1987) observed an activation of N mineralization, with the casts having 270 percent more ammonia than the bulk soil.

Within a year of application of vermiculture technology to the saline soil, 37 percent more N, 67 percent more P2O5 and 10 percent more K2O were recorded as compared to chemical fertilizer (Phule, 1993).

Atiyeh at al (2002) conducted an extensive review. The authors stated that: “These investigations have demonstrated consistently that vermicomposted organic wastes have beneficial effects on plant growth independent of nutritional transformations and availability. Whether they are used as soil additives or as components of horticultural soil less media, vermicomposts have consistently improved seed germination, enhanced seedling growth and development, and increased plant productivity much more than would be possible from the mere conversion of mineral nutrients into more plant-available forms.”
Cationic exchange rate

An important and often unrecognized feature of vermicast is its cationic exchange rate. This is the rate at which the cat ionic soil trace elements can attach themselves to vermicast.

Everything in nature has an electrical charge. Some charges are positive, cations, and some are negative, anions. Organic vegetative matter is anionic and, because vermicast is highly vegetative matter, it is strongly anionic. Most trace elements are cationic.

In simple terms this means that trace elements are attracted to vermicast and readily bond to it in the same way that opposite poles of a magnet attract each other. Plants have a stronger pull than the vermicast and can therefore draw the trace elements away from the vermicast and into their roots.

Atiyeh et al. (2000) found that compost was higher in ammonium, while Vermicompost tended to be higher in nitrates, which is the more plant-available form of nitrogen.

Vermicasts are excellent media for harbouring N-fixing bacteria (Bhole, 1992).

Earthworms have multiple, interactive effects on rates and patterns of nitrogen mineralization and immobilization in natural and managed ecosystems (Edwards and Lofty, 1977; Lee, 1983; Lavelle and Martin, 1992; Blair et al., 1995b).

Soil benevolent biota (microbes)

Earthworms not only disperse microorganisms important in food production but also associated with mycorrhizae and other root symbionts, biocontrol agents and microbial antagonists of plant pathogens as well as microorganisms that act as pests (Edwards and Bohlen, 1996).

Several researchers have demonstrated the ability of earthworms to promote the dispersal of beneficial soil microorganisms through castings, including pseudomonads, rhizobia and mycorrhizal fungi (Edwards and Bohlen, 1996; Buckalew et al., 1982; Doube et al., 1994a; Doube et al., 1994b; Madsen and Alexander, 1982; Reddell and Spain, 1991; Rouelle, 1983; Stephens et al., 1994).

Earthworm casts are enriched in terms of available nutrients and microbial numbers and biomass, relative to the surrounding soil (Shaw and Pawluk, 1986; Lavelle and Martin, 1992).

Earthworms reject significant amounts of nutrients in their casts. In part these losses result from the intense microbial activity in their gut, and from their own metabolic activity. E.g. The elimination of N due to fast turnover of this element in microbial biomass. A significant proportion of C assimilated by earthworms is secreted as intestinal and cutaneous mucus with greater C:N ratios than those of the resource used (Lavelle et al., 1983; Cortez and Bouche, 1987).

Kale (1991) has attributed the improved growth in pastures and in other crops like rye and barley to the chemical exudates of the worms and microbes in association with them.
Tomati et al., (1983) related the beneficial influence of worm cast to the biological factors like gibberellins, cytokinins and auxins released due to metabolic activity of the microbes harboured in the cast.

It has also been indicated that the chemical exudates of worms and those of microbes in the cast, influence the rooting or shoots of layers. In a field trial Kale and Bano (1986) observed that the seedling growth of rice in nursery increased significantly due to Vermicompost application, and transplanting of seedlings could be made one or two days earlier than the usual practice. After transplanting the growth of seedlings in main field was more favourably influenced by worm cast than the chemical fertilizer. This was attributed to higher availability of nitrogen for plant growth. The improved growth was also attributed to the release of plant growth promoting compounds from worm cast, which in their opinion could easily replace the chemical fertilizers at nursery level.

Similarly, work at NSAC by Hammermeister et al. (2004) indicated that “Vermicomposted manure has higher N availability than conventionally composted manure on a weight basis”. The latter study also showed that the supply rate of several nutrients, including P, K, S and Mg, were increased by vermicomposting as compared with conventional composting.

These results are typical of what other researchers have found (e.g., Short et al., 1999; Saradha, 1997, Sudha and Kapoor, 2000). It appears that the process of vermicomposting tends to result in higher levels of plant-availability of most nutrients than does the conventional composting process.

The literature has less information on this subject than on nutrient availability, yet it is widely believed that Vermicompost greatly exceeds conventional compost with respect to levels of beneficial microbial activity.

Much of the work on this subject has been done at Ohio State University, led by Dr. Clive Edwards (Subler et al., 1998). In an interview (Edwards, 1999), he stated that Vermicompost may be as much as 1000 times as microbially active as conventional compost, although that figure is not always achieved. Moreover, he went on to say that “...these are microbes which are much better at transforming nutrients into forms readily taken up by plants than you find in compost – because we’re talking about thermophillic microbes in compost – so that the microbial spectrum is quite different and also much more beneficial in a Vermicompost. I mean, I will stick by what I have said a number of times that a Vermicompost is much, much preferable to a compost if you’re going in for a plant-growth medium.”

Many researchers have found that vermicast stimulates further plant growth even when the plants are already receiving optimal nutrition.

Atiyeh et al further speculate that the growth responses observed may be due to hormone-like activity associated with the high levels of humic acids and humates in vermicomposts: “...there seems a strong possibility that ...plant-growth regulators which are relatively transient may become adsorbed on to humates and act in conjunction with them to influence plant growth”.

There has been considerable anecdotal evidence in recent years regarding the ability of Vermicompost to protect plants against various diseases.
The theory behind this claim is that the high levels of beneficial microorganisms in Vermicompost protect plants by out-competing pathogens for available resources (starving them, so to speak), while also blocking their access to plant roots by occupying all the available sites.

This analysis is based on the concept of the "soil foodweb", a soil-ecology-based approach pioneered by Dr. Elaine Ingham of Corvallis, Oregon (see her website at http://www.soilfoodweb.com for more details). Work on this attribute of Vermicompost is still in its infancy, but research by both Dr. Ingham's labs and the Ohio State Soil Ecology Laboratory are very promising.

With regard to the latter institution, Edwards and Arancon (2004) report that "...we have researched the effects of relatively small applications of commercially-produced vermicomposts, on attacks by Pythium on cucumbers, Rhizoctonia on radishes in the greenhouse, and by Verticillium on strawberries and Phomopsis and Sphaerotheca fulginea on grapes in the field. In all of these experiments, the Vermicompost applications suppressed the incidence of the disease significantly.”

The authors go on to say that the pathogen suppression disappeared when the Vermicompost was sterilized, indicating that the mechanism involved was microbial antagonism.

In recent research, Edwards and Arancon (2004) report statistically significant decreases in arthropod (aphid, mealy bug, spider mite) populations, and subsequent reductions in plant damage, in tomato, pepper, and cabbage trials with 20% and 40% Vermicompost additions to Metro Mix 360 (the control). They also found statistically significant suppression of plant-parasitic nematodes in field trials with peppers, tomatoes, strawberries, and grapes. Much more research is required, however, before Vermicompost can be considered as an alternative to pesticides or alternative, non-toxic methods of pest control.

Moreover, the authors go on to state a finding that others have also reported (e.g., Arancon, 2004), that maximum benefit from Vermicompost is obtained when it constitutes between 10 and 40% of the growing medium.

**Case Study**

Apple farming at Clan Leslie - take less, waste less, make more
Farmers Weekly 21 October 2010
*Hayden Green*

By incorporating vermicomposting and worm-casting tea in its apple production system, Clan Leslie Estate has improved its fruit quality, reduced input costs and improved the soil and tree health in its orchards. Hayden Green visited Mike Leslie to find out more.

Mike Leslie farms in partnership with his father Nick and brother Graham on the Clan Leslie Estate near Harrismith in the Free State. Like’s farming philosophy is to keep things simple, but pay attention to detail. He’s passionate about apple production and about where sustainability is taking the enterprise. He combines technology with applicable management and biological farming techniques to produce fruit that looks good, is healthy and nutritious, and exceeds export quality requirements. To achieve quality and production goals, Mike also partners with nature’s prime recycler – the humble earthworm.

**Vermiculture – earthworm farming**

To branch out into exports, Clan Leslie established its apple production division in 1996. Five years ago, they decided to integrate vermiculture into the operation because of changing export regulations, specifically for chemical residue levels. “Our list of suitable chemicals was and still is shrinking due to global regulations and the green movement,”
Mike says. “Consumers are looking for residue-free fruit, and we had to find a different way of doing things.” Fruit destined for export is batch-tested five days before picking, and Mike felt that moving to natural pest and disease control in the form of “worm tea” would minimise the risk of residue on the fruit, increase its nutritional value, and reduce chemical use and withholding periods. He contacted private consultant Hennie Eksteen for advice on vermiculture, and partnered with vermiculture specialist Poerie Coetzee to manage it. This left Mike himself free to concentrate on orchard management. “I was initially concerned that salmonella and E. coli contamination from feedlot manure and chicken litter we used as compost base came through in the testing,” he admits. “But we tried the worm tea in selected apple blocks and the results were perfect. The earthworms destroyed all pathogens in the manure, giving us the confidence to freely use compost tea.”

**Foliar and soil-feed teas**

“Foliar-feed tea requires an anaerobic process,” explains Mike. “We mix the earthworm castings with water, molasses, ground Lucerne and fishmeal, and brew the mixture in 1 000ℓ vats for three weeks. When it’s ready, we dilute the tea with water and use it as a foliar feed, sprayed at 80ℓ/ha.” Likewise, converting the solid material in worm castings into a liquid enables a practical, accurate and uniform application of soil-feed tea throughout the orchard. Soil-feed tea is made aerobically by pumping a large volume of air through it for up to 24 hours. Once the correct microbe population is reached (established by microscopic examination), the tea must be applied undiluted at 200ℓ/ha within a few hours before the aerobic bacteria die from a lack of oxygen. Follow-up irrigation further washes the tea into the soil. The total cost of foliar and soil-feed tea production and application is around R12 625/ha per season. This will decline in time as the orchard health improves and less spraying is needed.

**Mulching – retaining a natural balance**

“In nature, fruiting trees are part of a complicated ecological system, existing in symbiotic relationships with the fauna and other flora to sustain a healthy fruiting cycle,” says Mike. He’s concerned about the consequences and economic sustainability of a system of constant harvesting, with synthetic chemicals as the only inputs. So, mimicking nature, he scatters tree pruning clippings and other plant residue around the base of the trees to eventually decompose and form mulch. “We use nine 1,5m-diameter round bales of wheat residue to every 200m of tree row,” he explains. “This equates to 104 bales, or 26t of dry plant material, per hectare, and lasts for three to four years. Nothing is wasted.” The mulch, besides retaining moisture, feeds the bacterial processes stimulated by the soil-feed worm tea. Mike points to the contrast between mineral soil and the rich organic matter resulting from earthworm activity. “The earthworms manage the environment for me,” he says. “The soil is moving towards a natural state of balance (homeostasis) without chemical fertiliser.” He estimates that this production system needs one-third less irrigation water. “The savings are significant.” Mike was astonished when he first saw the increase in root growth as a result of the mulch and soil feed. “This increased nutrient uptake has resulted in healthier, stronger apple trees.”

**A competitive advantage**

“Quality counts. The market is prepared to pay for an apple that tastes better and, more importantly, lasts longer,” says Mike. Mulching with worm tea had precisely this effect, increasing demand for Clan Leslie apples from clients in Africa, where the cold supply chain isn’t as advanced as other export markets. “The local informal market is massive, and is prepared to pay premium prices for quality fruit that will last,” he explains. Although being situated in the south-eastern Free State gives Clan Leslie a three-week harvesting advantage over its Cape competitors, the unseasonal heavy frosts are a problem. Mike warns that worm tea is no silver bullet, and that balancing the soil is a slow process. Over the last five years, he has recorded an average increase from 8 Brix
to 12 Brix in his plants, correlating directly to frost resilience. An SMS early warning system notifies him to irrigate when air temperature drops below 5°C. Incorporating earthworms has increased yields from 50t/ha to 75t/ha in Pink Lady apples, and by 15t/ha in other varieties.

The path towards more sustainable production on the 66ha apple orchard constantly challenges Mike. “In the future I would define myself increasingly as a carbon farmer who produces apples,” he says.

Based on the success of the worm tea in the orchards, he aims to produce low-carbon-footprint apples with a superior nutritional value. Worm tea has been so successful in the apple orchards that he intends to expand it to the other Clan Leslie enterprises.

Contact Mike Leslie on 082 770 0306 or e-mail mike@clanleslie.co.za.

**In Conclusion:**

At Davley Organics we have consistently seen the benefit of vermicast with our own vegetables and trees and the crops of our customers. We have grown vegetables for ourselves and the staff for the last few years applying only a handful of vermicast per seedling every time we plant and have never had to spray against pests or add anything else. We consistently harvest great veggies all year round. We believe in this natural fertiliser because we have consistently seen it work well.

One of the great benefits is that by consistently applying vermicast as you would any other fertiliser you improve and rehabilitate the overall nature of the soil in which your crops are planted. Therefore over time your inputs in terms of fertilisers and water naturally decrease. This translates into saved costs while enjoying greater yields from crops that are healthy and increasingly pest resistant.

We understand that farmers get used to doing things a certain way and none of us like the hassle of change. We also understand that farmers are bombarded with new products that make all sorts of wild and fantastic claims. We would like you to simply consider the following:

1. Vermicast has been around since Adam, it is not man-made and it occurs naturally in the wild. If you scratch open the forest floor of a natural forest like the Knysna forests, you will find these earthworms processing the organic material. Have a look at the general health and size of those trees that have been there for decades without any fertiliser inputs or irrigation from man.
2. Vermicomposting centres are numerous in Cuba. When the Soviet Union fell, it became impossible for them to import commercial fertilizer. Vermicompost has been the largest single replacement for commercial fertilizer by Cuba.
3. In India, an estimated 200,000 farmers practice vermicomposting and one network of 10,000 farmers produce 50,000 metric tons of Vermicompost every month.

We encourage you to Google vermicast and do further research for yourself, to date we have never been able to find any evidence that vermicast has limited or no effect on commercial crops or any other plant. Please don’t hesitate to contact us to discuss how vermicast can improve your crops. Kind Regards The Davley Organics Team
Earthworms can eat their weight in a day

Vermicast boosts all plants immune systems making them resistant to pests and diseases.

Vermicast is perfectly balanced. It cannot burn or damage any plant.

Vermicast will not deteriorate or leach away like chemical fertilizers

Charles Darwin spent 39 years studying earthworms more than 100 years ago.